Resource Action: EWG – 13B	**Task Force Recommendation Category: 1**

Fish Rearing Habitat Enhancement in the Low Flow Channel

Date of Field Evaluation: N/A

Evaluation Team: Richard Harris, Koll Buer and Bruce Ross. Information also received from Tom Boullion (DWR). (See also evaluation for EWG 13A)

Description of Potential Resource Action:
This Resource Action would provide additional salmonid rearing habitat within the low flow channel of the Feather River by creating additional cover, edge, and flow complexity. This could be accomplished through the addition of large woody debris (LWD) (see EWG 13A), boulders, and other objects, and by the creation of mid-channel gravel islands. The main goal of these enhancements would be to provide in-stream cover. These structures may also increase the area of shallow-edge habitats within existing riffles and glides. This Resource Action would benefit rearing steelhead (primary target) and Chinook salmon (secondary target).

The following Resource Actions are either similar to or directly related to the proposed measure:

- EWG-13A and EWG-20, that are aimed at improving rearing habitat in the Feather River through placement of wood.
- EWG-16A and EWG-16B, that would enhance or create side channel habitat in the low flow reach.
- EWG-89, involving levee setbacks to increase access of the river to its floodplain.

Nexus to Project:
Lake Oroville prevents downstream migration of sediment and LWD into the lower Feather River from its upstream tributaries. Partly as a consequence of this, the low flow channel has a limited diversity of instream habitats for anadromous fish. Habitat diversity and availability is further limited due to the highly regulated flow regime in the low flow channel.

Potential Environmental Benefits:
The primary intended benefit is creation of rearing habitat. However, there could be other potential benefits (or effects) as well. Obstructions in the channel can encourage sediment sorting and storage, moderate peak flows and create pools. Obstructions can also provide substrate and food for invertebrates, create shelter for both aquatic and terrestrial wildlife, create surfaces suitable for recruitment of riparian plants and generally contribute to the complexity of instream habitat conditions.

The low flow channel is an intensively utilized spawning area for anadromous salmonids. Improving rearing habitat would probably increase survival of juveniles.

Potential Constraints:
As with Resource Action EWG-13A, that proposes placement of LWD in the low flow channel, any obstructions to flow could impair navigability and/or have unforeseen effects on channel behavior. An additional constraint to this Resource Action would be locating and transporting materials such as boulders to the low flow channel from source areas.

Existing Conditions in the Proposed Resource Action Implementation Area:
The low flow channel is a regulated stream reach. Flows are nearly always about 600 cubic feet per second (cfs) except when peak runoff events require flood control releases from Lake Oroville. At those times, flows may exceed 100,000 cfs for sustained periods. Flows of this magnitude occurred in 1965, 1986, and 1997.

The low flow channel is confined between levees. There are some mid-channel bars, lateral bars, and islands that are relatively stable within the current flow regime. The slope gradient in the low flow channel ranges from 0.06% to 0.2%. Flow widths vary from 200-500 feet at normal regulated flows of 600 cfs to 2,500 feet at flood control flows of up to 100,000 cfs. Water velocities range from 1-4 feet per second (fps) at 600 cfs to 12 fps at 100,000 cfs.

Delivery of sediment and LWD to the low flow reach is blocked by Oroville facilities. Recruitment of LWD from riparian vegetation along the low flow reach is fairly limited. As a consequence, obstructions to flow are lacking, and creation and enlargement of islands is not occurring.

Design Considerations and Evaluation:
The placement of instream structures has been done extensively in river systems in California and in other Pacific Northwest states. Most of these projects have been done in small to medium-sized streams, especially on the north coast of California. Although LWD is commonly used for these projects, boulders, gabion baskets, bioengineered structures, and other materials are also used, often together (Flosi et al. 1998). Structural placements have rarely been done on larger streams or rivers in California that are comparable to the low flow channel portion of the Feather River. When they have been done on larger streams, logs or revetments extending from the banks have been used mainly to create local scour pool habitat. The success of such projects has been variable. As a rule, placements are usually done as single logs, groups of logs or as combinations of logs and boulders. Anchoring and cabling is a common practice for enhancing the stability of structures high flow events.

If the objective is to create rearing habitat, structures must be stable in relation to the prescribed flow regime. That would not be difficult in the regulated low flow channel. Materials just need to be properly sized and anchored to withstand the regulated flows.

However, the low flow channel is subject to occasional extreme peak flows. These are of a great enough magnitude that no instream structures could be large enough or anchored well enough to survive them. Therefore, this Resource Action should be viewed as providing temporary benefits.

On larger streams in the Pacific Northwest, there has been some work with engineered structures consisting of cabled and anchored large logs and/or boulders commonly placed at the head of islands or side channels. These structures are typically used to increase sediment recruitment and create sites for riparian vegetation recruitment. They are not intended primarily to create rearing habitat.

In the low flow channel, probably the best opportunities for using structures to improve rearing habitat are in backwater and side channel areas away from the thalweg, however candidate locations were not evaluated for this report. Structure placements may enhance juvenile salmonid rearing habitat diversity and quality for the life of the placement (until the next high flow event) or until the break down of the material (in the case of structures involving LWD). There is also the potential that these backwater structural placements would become refuges for predators of juvenile salmonids.

Consideration should also be given to the use of structures, particularly boulders, to enhance retention of spawning gravels. Boulders placed at upstream riffle crests can deflect flows around gravels that are intentionally placed to improve habitat.

There would be permitting requirements for structural placements. These would include, at the minimum, 1601-1603 Streambed Alteration Agreements from the Department of Fish and Game, a 401 Certification from the State or Regional Water Quality Control Board and a 404 Permit from the US Army Corps of Engineers.

The way to evaluate the effectiveness of structural placements is to: 1) monitor the placement itself and the habitats it creates; and 2) to monitor fish use of structures and associated habitats. The latter, termed “validation monitoring” has recently gained wide recognition amongst fisheries biologists as the true test of restoration project effectiveness (Botkin et al. 2000).

Synergism and Conflicts:
Synergisms could be created if this measure is planned in conjunction with other measures proposing creation of side channel habitat, gravel placement, and flow regimes favorable to fish. Conflicts could occur if navigability is impaired or unforeseen channel behavior (i.e., bank erosion) occurs due to placements.

Uncertainties:
The main uncertainties associated with this measure relate to the channel behavior that may result from placing obstructions in the channel. These can be avoided or minimized by confining structural placements to side channel and backwater areas. There are

other potential uncertainties about the environmental impacts of construction within the channel.

Cost Estimate:
Costs for structural placements may vary tremendously depending on the nature of the structure, engineering design, availability of materials and installation difficulties. Probably the largest costs would be associated with transporting materials to the site and heavy equipment operation. In general, costs for structural placements would probably be moderate in comparison to the costs for other more intensive habitat improvements (e.g., side channel creation, levee setbacks, etc.). The estimated range of costs for each structural placement would be $1,000-$100,000. The lower cost would be for placement of single boulders with minimal engineering design. The higher cost would be for complex structures involving multiple boulders and/or logs, and sophisticated design and permitting.

Recommendations:
This measure, along with the use of LWD (EWG-13A and EWG-20), side channel creation and enhancement (EWG-16A) and a riparian enhancement program (EWG-17 and EWG-51) to improve rearing habitat for salmonids in the low flow channel should be considered complementary. The treatments applied in specific locations will depend on objectives for rearing habitat improvement. Study Plan, SP-G2 will provide information on current habitat types and conditions limiting salmonid production in the low flow reach. The findings of that study plan should be incorporated into evaluations of habitat improvement Resource Actions. Evaluations of proposed habitat improvements should explicitly analyze the effects of alternative flow management proposals on the ability to create and sustain rearing habitats.

Placement of obstacles in association with gravel placement (see EWG-92) could both enhance gravel retention and potentially increase the area of suitable spawning habitat in the low flow reach. Although EWG-13B is intended to improve rearing habitat, the application to spawning habitat enhancement deserves further evaluation. Boulders might be most appropriate for promoting gravel retention. Another option that could be explored in conjunction with raking or ripping gravels (EWG-18) would be piling cobbles as flow deflectors to protect gravel deposits.

Literature Cited:
Botkin, D.B.; Peterson, D.L.; Calhoun, J.M., technical editors, 2000. *The Scientific Basis for Validation Monitoring of Salmon for Conservation and Restoration Plans*. Olympic Natural Resources Technical Report. University of Washington, Olympic Natural Resources Center, Forks, Washington.

Flosi, Gary; Downie, Scott; Hopelain, James; Bird, Michael; Coey, Robert; Collins, Barry (1998). *California Salmonid Stream Habitat Restoration Manual, Third Edition.* Sacramento, California, California Department of Fish and Game, Inland Fisheries Division.